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REMARKS

Claim 21 differs from existing technology by increasing the length L of the piston rod 18 while keeping the length r of the crank arm fixed (FIG 14). The trend in engines is to have a short stroke and a short piston rod to gain high rpm. "This means that an engine can run much faster - up to 15,000 rpm in a Champ Car engine – but relatively little torque." See attached copy from howstuffworks taken from the internet.

A copy of 1 page of "The Most Powerful Diesel Engine in the World" is attached. It shows the "crosshead" design that keeps the piston square in the cylinder but uses a short connecting rod. This is opposite to my long connecting rod 18 with a small angle θ .

Claim 21.(new) is justified **entirely** by the math shown in the BACKGROUND OF THE INVENTION section of the CIP pages 2,3. The math shows how a longer length L of the piston rod 18 with a fixed crank arm r allows a small displacement of the piston 38 and small angle θ to cause a large angular displacement of the shaft 8 **before** reaching the $\text{Lim } \cos \theta = 1.0$.

$$\theta \rightarrow 0.0$$

Claim 21 intends that the offset piston description that dominates the CIP can be reached with increasing effectiveness by increasing the piston rod length L while keeping the length of the crank arm r fixed. Claim 21 does not intend to reduce the importance of the offset piston emphasized and claimed in the CIP. The offset piston explains several important features that cannot be achieved with the engine claimed by claim 21.

Equations from the CIP are used in the following 2 examples to make the point for Claim 21. The large increase in α with a small displacement of piston 38 and small increase in θ is evident:

$\cos \theta = \cos\{\sin^{-1}[(r/L)\sin \alpha]\}$ taken from the CIP page 3.

$\cos \Phi = \cos(90 - \{\alpha + \sin^{-1}[(r/L)\sin \alpha]\})$ taken from the CIP page 3.

$a = r(1 - \cos \alpha)$ taken from the CIP page 2.

Solve $\cos \theta$ for α :

$$\theta = \sin^{-1}[(r/L)\sin \alpha]$$

$$\sin \theta = (r/L)\sin \alpha$$

$$\sin \alpha = (L/r)\sin \theta$$

$$\alpha = \sin^{-1}[(L/r)\sin \theta]$$

Example 1

Let: $\theta = 17^\circ$, $L = 5''$, $r = 1.5''$

$$\alpha = \sin^{-1}[(10/1.5)\sin 17^\circ] = 77.052^\circ \text{ FV1 is tangent to crank circle d.}$$

$$\cos \theta = \cos 17^\circ = .9563$$

$$\cos \Phi = \cos(90 - \{77.052 + \sin^{-1}[(1.5/10)\sin 77.052]\}) = .9969$$

$$\cos \theta \cos \Phi = (.9563)(.9969) = .9533 = 95.33\% \text{ efficiency when FV1 is tangent to circle d.}$$

$$a = 1.5''(1 - \cos 77.052^\circ) = 1.164'' \text{ piston displacement when FV1 is tangent to circle d.}$$

Example 2

Let: $\theta = 8.5^\circ$, $L = 10''$, $r = 1.5''$

$$\alpha = \sin^{-1}[(10/1.5)\sin 8.5^\circ] = 80.196^\circ \text{ angular displacement when FV1 is tangent to circle d.}$$

$$\cos \theta = \cos 8.5^\circ = .9890$$

$$\cos \Phi = \cos(90 - \{80.196 + \sin^{-1}[(1.5/10)\sin 80.196]\}) = .9997$$

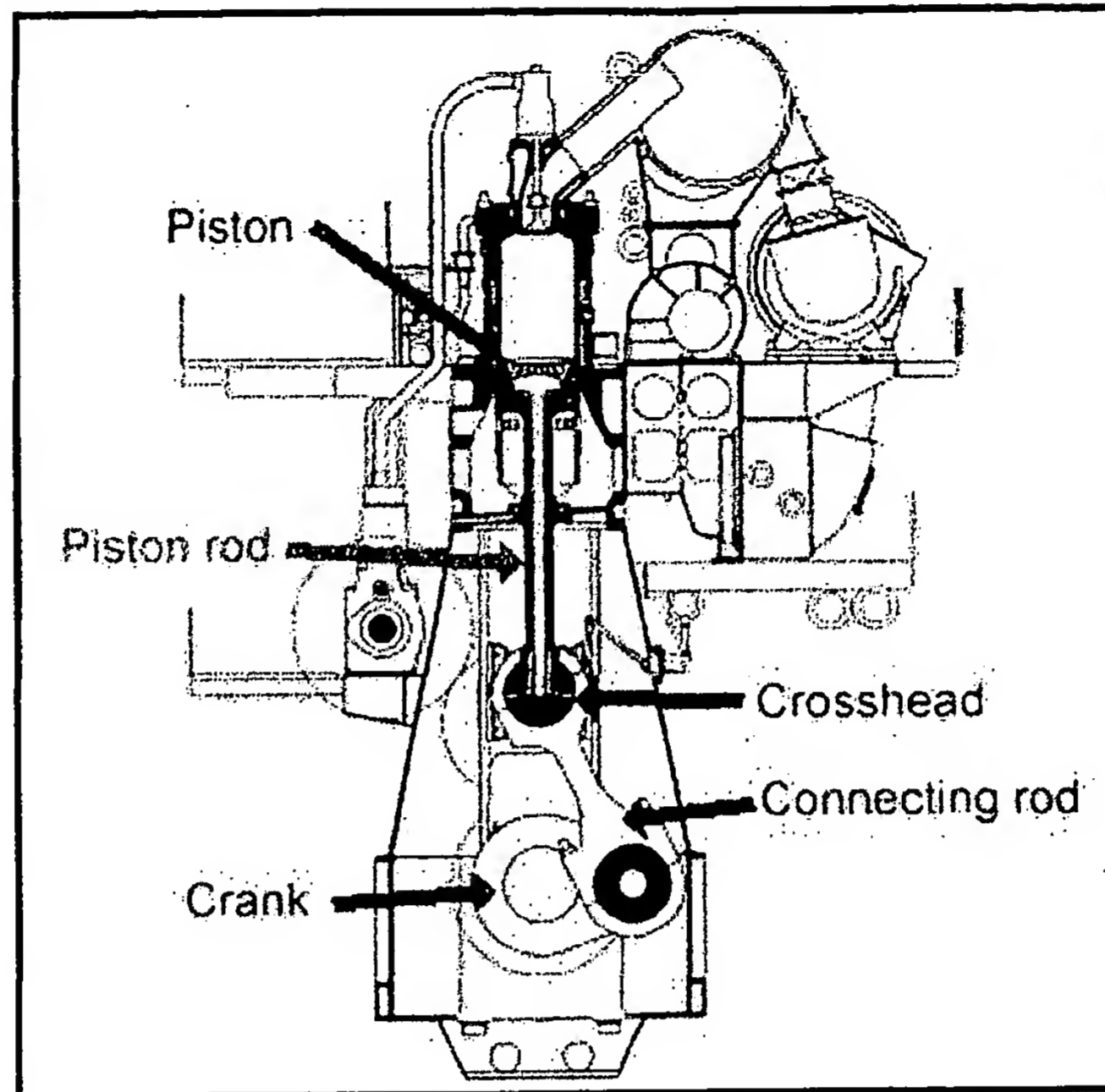
$$\cos \theta \cos \Phi = (.9890)(.9997) = .9887 = 98.87\% \text{ efficiency when FV1 is tangent to circle d.}$$

$$a = 1.5''(1 - \cos 80.196^\circ) = 1.245'' \text{ piston displacement when FV1 is tangent to circle d.}$$

The crank engine's efficiency is still at or near zero at or near top dead center.


R.E. Giuliani

Inventor/Applicant



The internals of this engine are a bit different than most automotive engines.

The top of the connecting rod is not attached directly to the piston. The top of the connecting rod attaches to a "crosshead" which rides in guide channels. A long piston rod then connects the crosshead to the piston.

I assume this is done so the sideways forces produced by the connecting rod are absorbed by the crosshead and not by the piston. Those sideways forces are what makes the cylinders in this engine get oval-shaped over time.

Installing the "thin-shell" bearings. Crank & rod journals are 38" in diameter and 16" in length.



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Why do big diesel engines and race car en have such different horsepower ratings?



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Let's start by answering the question and then look at why the world works tha

The answer to your question has to do with the way the two engines are design. A liter diesel engine has a long stroke. That means that the piston is traveling a distance up and down in its cylinder on each cycle. A racing engine, on the other hand, has a short stroke. The piston in a racing engine has a large diameter for the engine. It goes up and down a relatively short distance on each cycle. This means that a racing engine can run much faster -- up to 15,000 RPM in a Champ Car engine -- but with relatively little torque. A large diesel engine usually cannot get above 2,000 RPM because of the long stroke. The torque is what lets your engine pull a load up a hill.

So why does an engine with huge torque and low maximum RPM get a low horsepower rating? If you have read the article entitled How Horsepower Works, then you know that 1 horsepower is equal to 33,000 foot-pounds of work per minute. By this measure, an engine can raise 33 pounds 1,000 vertical feet in a minute, or 330 pounds 100 feet in a minute, or 3,300 pounds 10 feet in a minute, and so on.

What an engine naturally produces, however, is torque. Think about one piston in a gasoline engine. When the gasoline ignites, it pushes on the piston, and the pressure on the crankshaft, causing it to turn. The crankshaft feels some number of pounds of torque in the process. There are three variables that affect torque:

- The size of the piston face
- The amount of pressure that the ignited fuel applies to the face of the piston
- The distance the piston travels on each stroke (therefore the diameter of the crankshaft). The bigger the diameter of the crankshaft, the bigger the leverage, therefore the more torque.

There is a direct relationship between horsepower and torque. You can convert torque to horsepower with the following equation:

$$\text{HP} = \text{Torque} * \text{RPM} / 5,252$$

That 5,252 number, by the way, comes from dividing 33,000 by $(2 * \pi)$. Imagine 33,000 foot-pounds and walking it around in a circle rather than a straight line. If you took a 10 foot pole and attached it to a vertical axle, the circumference of

$$\text{circumference} = 10 * 2 * \pi = 62.8 \text{ feet}$$

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If one horse is pushing on the pole with 100 pounds of force (1,000 foot-pound) it can move the pole at 5.25 RPM. Torque and horsepower are directly related other.

You can see from the horsepower equation that high RPM values favor horsepower. Take an engine with a certain torque and run it at very high revs, it can generate horsepower even though its torque hasn't changed at all. A racing engine can have relatively low torque, but because it can rev so high it gets a great horsepower. A diesel has huge torque, but "gets no respect" in terms of horsepower because it never gets above 2,000 RPM. This "makes sense" – if two engines produce the same torque, the one that can do it more times per minute does more work and therefore has more power.

The difference in maximum RPM ratings also tells you why trucks need so much torque. A race car engine might idle at 1,000 RPM and can accelerate to 15,000 RPM – a multiplier of 15. A big diesel might have a multiplier of only 2 or 3. Because the RPM range of a diesel is so small, there needs to be lots of difference between its minimum and maximum RPM to keep the engine in its productive RPM range at any speed.

Here are several interesting links:

- [How Champ Cars Work](#)
- [How NASCAR Race Cars Work](#)
- [How Diesel Engines Work](#)
- [How Horsepower Works](#)
- [Glossary of CART terms \(see "Engine"\)](#)

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